

REMARKS

Claims 1-8 and 10-21 are pending in the application. Claims 1-6 are withdrawn from consideration as being directed to non-elected inventions. In the Office Action of February 24, 2004, the Examiner made the following disposition:

- A.) Rejected claims 7, 8, 10, 11, 16, and 19-21 under 35 U.S.C. §103(a) as being unpatentable over *Hayes* in view of *Hotchkiss* and *Behun*.
- B.) Rejected claims 12, 13, and 17 under 35 U.S.C. §103(a) as being unpatentable over *Hayes*, *Hotchkiss* and *Behun*, and further in view of *Nishikawa et al.* and *Denning et al.*
- C.) Rejected claims 14 and 15 under 35 U.S.C. §103(a) as being unpatentable over *Hayes*, *Hotchkiss*, *Behun*, *Nishikawa et al.* and *Denning et al.*, and further in view of *Okumura*.
- D.) Rejected claim 18 under 35 U.S.C. §103(a) as being unpatentable over *Hayes*, *Hotchkiss* and *Behun*, and further in view of *Jackson*.

Applicant respectfully traverses the rejections and addresses the Examiner's disposition as follows:

- A.) Rejection of claims 7, 8, 10, 11, 16, and 19-21 under 35 U.S.C. §103(a) as being unpatentable over *Hayes* in view of *Hotchkiss* and *Behun*:

Applicant respectfully disagrees with the rejection.

Claims 7 and 20 have been amended to clarify that the solder layers are eutectic solder layers. Claim 19 has been amended to correct an informality that the metal bumps are metal ball bumps.

Referring to Applicant's Figures 1 and 5 for illustrative purposes, Applicant's independent claim 7, as amended, claims a method of producing a semiconductor apparatus in which metal ball bumps 116b are formed in direct contact with a circuit pattern 111 of a semiconductor device formed on a semiconductor substrate in a semiconductor wafer. A resin film 117 is formed on a circuit pattern forming surface of the semiconductor device so as to seal spaces between the metal ball bumps 116b and to become thinner than a height of the metal ball bumps 116b. The surfaces of the metal ball bumps 116b projecting out from the resin film 117 are cleaned. After the cleaning step, eutectic solder layers 118 different in composition from the metal ball bumps 116b are formed on the surfaces of the metal ball bumps 116b. At least one of the semiconductor chips is mounted on a mounting board 200 from a bump forming surface side of the semiconductor chip so as to connect the eutectic solder layers 118 of the semiconductor chip 110 to the mounting board 200 with the resin film 117 directly contacting the semiconductor chip 110 and

not directly contacting the mounting board 200.

Thus, as shown in Applicant's Figure 5, the eutectic solder layers 118 are formed on the metal ball bumps 116b. As shown in Figure 1, the resin film 117 does not directly contact the mounting board 200.

This is unlike *Hayes* in view of *Hotchkiss* and *Behun*. None of *Hayes*, *Hotchkiss* or *Behun*, taken singly or in combination, disclose or suggest metal ball bumps formed in direct contact with a circuit pattern, with eutectic solder layers formed on the surfaces of the metal ball bumps. As acknowledged by the Examiner, *Hayes* fails to disclose metal ball bumps formed in direct contact with a circuit pattern. (Office Action of 2/14/04, page 3). Instead, as stated by the Examiner, *Hayes* discloses solder columns 3 formed in direct contact with a circuit pattern. *Id.* *Hayes's* solder columns protrude from a dielectric layer 4 and metal ball bumps 9 are formed *on top of* its solder columns 9 and dielectric layer 4, with no eutectic solder layers formed on its metal ball bumps 9.

The Examiner argues that since *Hotchkiss* discloses metal ball bumps 114 formed in direct contact with a circuit pattern, metal ball bumps are allegedly substitutes for solder columns, and therefore it allegedly would have been obvious to substitute *Hayes's* solder columns with metal ball bumps to allegedly disclose or suggest Applicant's claimed metal ball bumps having eutectic solder layers formed thereon. Applicant respectfully disagrees. To begin with, *Hayes* teaches using solder columns 3 as conductive paths through its dielectric layer 4, so that *Hayes's* metal ball bumps 9 can be electrically coupled to the underlying chip via the solder columns 3. *Hayes's* solder columns 3 are formed to serve as narrow vias in *Hayes's* dielectric layer 4. This is unlike *Hotchkiss's* metal ball bumps 114, which serve to solder-connect one device to another device.

Therefore, Applicant respectfully submits that *Hayes's* solder columns 3 do not serve the same purpose as *Hotchkiss's* metal ball bumps 114. *Hayes's* solder columns 3 serve as vias, and *Hotchkiss's* metal ball bumps serve as solder-connects. Further, neither *Hayes* nor *Hotchkiss* even discusses substituting a metal ball bump to be used as a via for a solder column used as a via. Therefore, it would not have been obvious to substitute *Hotchkiss's* metal ball bumps as vias for *Hayes's* solder column via.

Even if it would have been obvious to substitute *Hotchkiss's* metal ball bumps for *Hayes's* solder columns vias, to which Applicant urgently disagrees, *Hayes* in view of *Hotchkiss* still fails to disclose or suggest forming eutectic solder layers on the surfaces of any metal ball bumps. As discussed in Applicant's specification, by forming Applicant's claimed eutectic solder layers on

Applicant's claimed metal ball bumps, the height of the bumps is increased and the resistance to thermal stress is improved, the wettability with the solder at the time of mounting to the mounting board can be improved, and the reliability of connections can be further improved. (Specification, page 28, lines 9-14).

Nowhere do any of the cited references, taken singly or in combination, disclose or suggest forming eutectic solder layers on the surfaces of any metal ball bumps. *Hayes* discloses metal ball bumps 9, but fails to disclose or suggest forming eutectic solder layers thereon. *Hotchkiss* discloses metal ball bumps 114 with no eutectic solder layers formed thereon. *Behun* discloses an LMP solder 16 having a HMP metal ball bump 18 formed thereon.

Therefore, unlike Applicant's claim 7, none of the cited references, taken alone or in combination, disclose or suggest a metal ball bump having a solder layer formed thereon. Accordingly, *Hayes* in view of *Hotchkiss* and *Behun* fails to disclose or suggest claim 7.

Further, as discussed previously, the method disclosed in claim 7 is beneficially simpler than the Examiner's method allegedly suggested by the combination of *Hayes*, *Hotchkiss*, and *Behun*. It is simpler to form a eutectic solder layer on a metal ball bump, as in Applicant's claimed method, than to form a metal ball bump on a solder column or LMP solder, as in the cited references. For example, in *Hayes*, solder columns 3 must be formed before forming solder balls 9, which requires additional processing steps for forming the cavities into which the solder columns 3 are formed. And in *Behun*, HMP solder balls 18 must be formed and maintained prior to being placed on the LMP solder 16 and the LMP solder 16 being reheated for wetting to the HMP solder balls 18.

Therefore, for at least this additional reason, *Hayes* in view of *Hotchkiss* and *Behun* fails to disclose or suggest claim 7.

Claims 8, 10, 11, 16, and 19-21 depend directly or indirectly from claim 7 and are therefore allowable for at least the same reasons that claim 7 is allowable.

Applicant respectfully submits the rejection has been overcome and requests that it be withdrawn.

B.) Rejection of claims 12, 13, and 17 under 35 U.S.C. §103(a) as being unpatentable over Hayes, Hotchkiss and Behun, and further in view of Nishikawa et al. and Denning et al.:
Applicant respectfully disagrees with the rejection.

Applicant's independent claim 7 is allowable over *Hayes, Hotchkiss and Behun* as discussed above. *Nishikawa* and *Denning* still fail to disclose or suggest a metal ball bump having a eutectic solder layer formed thereon, with the eutectic solder layer mounted to a mounting board. Therefore, *Hayes, Hotchkiss and Behun*, and further in view of *Nishikawa* and *Denning* still fails to disclose or suggest Applicant's claim 7.

Claims 12, 13 and 17 depend directly or indirectly from claim 7 and are therefore allowable for at least the same reasons that claim 7 is allowable.

Applicant respectfully submits the rejection has been overcome and requests that it be withdrawn.

C.) Rejection of claims 14 and 15 under 35 U.S.C. §103(a) as being unpatentable over Hayes, Hotchkiss, Behun, Nishikawa et al. and Denning et al., and further in view of Okumura:
Applicant respectfully disagrees with the rejection.

Applicant's independent claim 7 is allowable over *Hayes, Hotchkiss, Behun, Nishikawa*, and *Denning* as discussed above. *Okumura* still fail to disclose or suggest a metal ball bump having a eutectic solder layer formed thereon, with the eutectic solder layer mounted to a mounting board. Therefore, *Hayes, Hotchkiss, Behun, Nishikawa*, and *Denning*, and further in view of *Okumura* still fails to disclose or suggest Applicant's claim 7.

Claims 14 and 15 depend directly or indirectly from claim 7 and are therefore allowable for at least the same reasons that claim 7 is allowable.

Applicant respectfully submits the rejection has been overcome and requests that it be withdrawn.

D.) Rejection of claim 18 under 35 U.S.C. §103(a) as being unpatentable over Hayes, Hotchkiss and Behun, and further in view of Jackson:

Applicant respectfully disagrees with the rejection.

Applicant's independent claim 7 is allowable over *Hayes, Hotchkiss and Behun* as discussed above. *Jackson* still fail to disclose or suggest a metal ball bump having a eutectic solder layer formed thereon, with the eutectic solder layer mounted to a mounting board. Therefore, *Hayes, Hotchkiss and Behun*, and further in view of *Jackson* still fails to disclose or

suggest Applicant's claim 7.

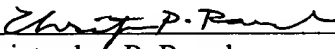
Claim 18 depends directly or indirectly from claim 7 and is therefore allowable for at least the same reasons that claim 7 is allowable.

Applicant respectfully submits the rejection has been overcome and requests that it be withdrawn.

CONCLUSION

In view of the foregoing, it is submitted that claims 7-8 and 10-21 are patentable. It is therefore submitted that the application is in condition for allowance. Notice to that effect is respectfully requested.

Respectfully submitted,

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